

Natural Gas Vehicle Cylinder Safety, Training and Inspection Project

10/05 – 12/08

Funded by DOE/NETL



November 20, 2008

Natural Gas Vehicle Cylinder Safety, Training and Inspection Project

Project Phases:

I – Public and Industry Awareness Campaign

II – Training Scholarships or Tuition (Funding) Assistance

III – Evaluate Current Training and Testing Practices

IV – CNG Cylinder Safety Monitoring & Investigation Activities

V – CNG Cylinder Recertification

VI – CH₂/ HCNG Cylinder Safety Considerations

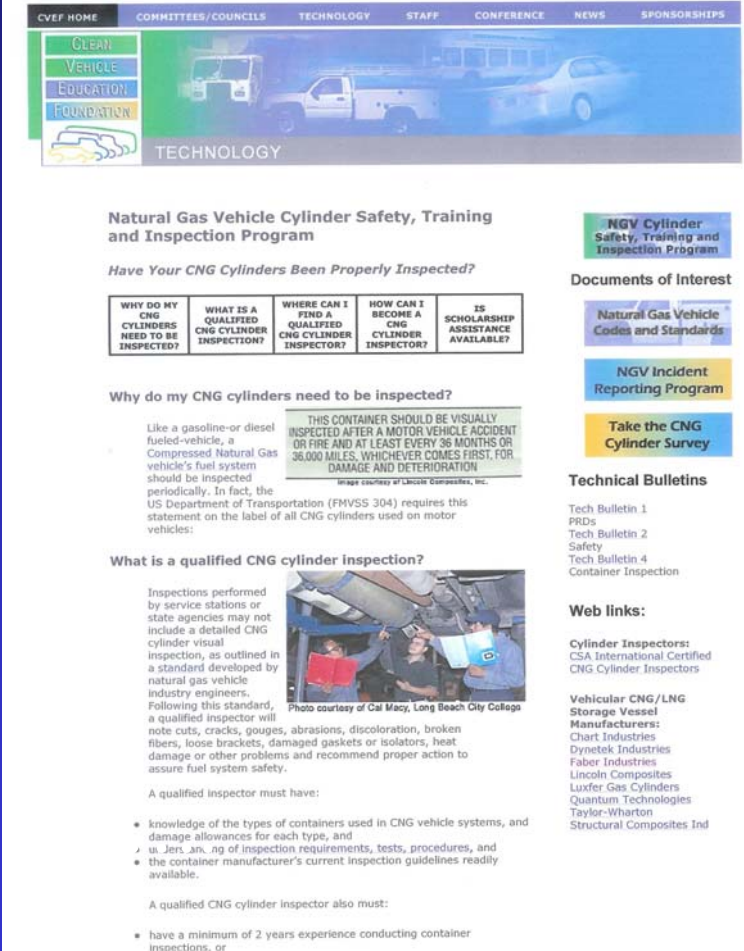


Phase I – Public and Industry Awareness Campaign

Highlights:

Website: <http://www.cleanvehicle.org/technology/cylinder.shtml>

See www.cleanvehicle.org
and click on “NGV Cylinder
Safety, Training and
Inspection Program”



The screenshot displays the website for the Clean Vehicle Education Foundation (CVEF). The navigation bar at the top includes links for HOME, COMMITTEES/COUNCILS, TECHNOLOGY, STAFF, CONFERENCE, NEWS, and SPONSORSHIPS. The main header features the CVEF logo and a large image of various vehicles (a truck, a pickup truck, and a car) with the word "TECHNOLOGY" below it.

The main content area is titled "Natural Gas Vehicle Cylinder Safety, Training and Inspection Program". Below this title is a question: "Have Your CNG Cylinders Been Properly Inspected?". A table with five columns provides quick links to various resources:

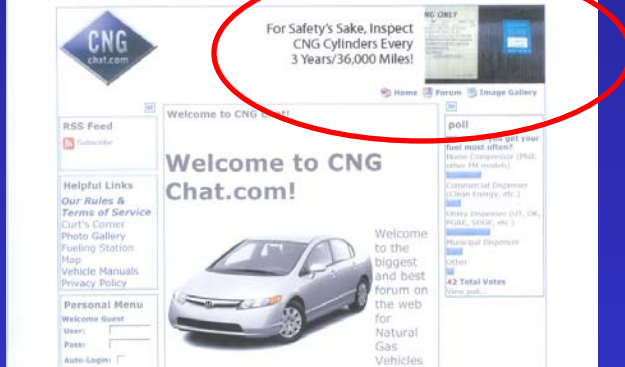
WHY DO MY CNG CYLINDERS NEED TO BE INSPECTED?	WHAT IS A QUALIFIED CNG CYLINDER INSPECTOR?	WHERE CAN I FIND A QUALIFIED CNG CYLINDER INSPECTOR?	HOW CAN I BECOME A CNG CYLINDER INSPECTOR?	IS SCHOLARSHIP ASSISTANCE AVAILABLE?
<p>Why do my CNG cylinders need to be inspected?</p> <p>Like a gasoline-or diesel fueled-vehicle, a Compressed Natural Gas vehicle's fuel system should be inspected periodically. In fact, the US Department of Transportation (FMVSS 304) requires this statement on the label of all CNG cylinders used on motor vehicles:</p> <p>THIS CONTAINER SHOULD BE VISUALLY INSPECTED AFTER A MOTOR VEHICLE ACCIDENT OR FIRE AND AT LEAST EVERY 36 MONTHS OR 36,000 MILES, WHICHEVER COMES FIRST, FOR DAMAGE AND DETERIORATION</p> <p><small>Image courtesy of Lincoln Composites, Inc.</small></p>	<p>What is a qualified CNG cylinder inspection?</p> <p>Inspections performed by service stations or state agencies may not include a detailed CNG cylinder visual inspection, as outlined in a standard developed by natural gas vehicle industry engineers. Following this standard, a qualified inspector will note cuts, cracks, gouges, abrasions, discoloration, broken fibers, loose brackets, damaged gaskets or isolators, heat damage or other problems and recommend proper action to assure fuel system safety.</p> <p>A qualified inspector must have:</p> <ul style="list-style-type: none">• knowledge of the types of containers used in CNG vehicle systems, and damage allowances for each type, and• u. Jers .am. ng of inspection requirements, tests, procedures, and• the container manufacturer's current inspection guidelines readily available. <p>A qualified CNG cylinder inspector also must:</p> <ul style="list-style-type: none">• have a minimum of 2 years experience conducting container inspections, or			

Below the table, there is a photo of two people inspecting a CNG cylinder, with the caption "Photo courtesy of Cal Macy, Long Beach City College".

On the right side of the page, there are several sections:

- Documents of Interest:** Includes links to "NGV Cylinder Safety, Training and Inspection Program", "Natural Gas Vehicle Codes and Standards", "NGV Incident Reporting Program", and "Take the CNG Cylinder Survey".
- Technical Bulletins:** Lists "Tech Bulletin 1 PDI's", "Tech Bulletin 2 Safety", "Tech Bulletin 4 Container Inspection".
- Web links:** Includes "Cylinder Inspectors: CSA International Certified CNG Cylinder Inspectors", "Vehicular CNG/LNG Storage Vessel Manufacturers: Chart Industries, Dynetek Industries, Faber Industries, Lincoln Composites, Luxfer Gas Cylinders, Quantum Technologies, Taylor-Wharton, Structural Composites Ind".

80 press releases, advertisements, web links, articles, presentations, exhibits, etc.



RECOMMENDED TO CNGV BY DOE OF STATIONARY GAS VEHICLE

A SAFETY AWARENESS MESSAGE FOR NATURAL GAS VEHICLE OPERATORS

HAVE YOUR CNG CYLINDERS BEEN PROPERLY INSPECTED?

Did you know that a visual inspection should be performed every 36 months or 36,000 miles?

Vehicles that run on Compressed Natural Gas (CNG) should have their fuel systems checked periodically by a qualified inspector. In fact, federal DOT regulations require that all CNG cylinder labels include the notice highlighted above.

A qualified inspector is trained to look for cuts, abrasions, abnormal wear and other damage or deterioration that may compromise the continued safe operation of a CNG fuel system, and recommend corrective action.

To locate a qualified inspector in your area or to learn more about how you can become a trained and certified inspector, contact the Clean Vehicle Education Foundation (CVEF) at <http://www.cleanvehicle.org/technology/cylinders.html>. You may qualify for training and certification testing scholarship funds available through a US DOE underwritten program administered by CVEF.

For more information, visit our website or contact Hank Seiff (hseiff@cleanvehicle.org).

www.cleanvehicle.org

May 9, 2006 Convention & Tradeshow News

NGView

36 Months/36,000 Miles

That's how often CNG cylinders must be inspected to ensure the safety of your NOV operation

By Hank Seiff

Like with a gasoline- or diesel-fueled vehicle, a natural gas vehicle's fuel system should be inspected periodically. Indeed, the U.S. Dept. of Transportation requires that compressed natural gas (CNG) cylinders used on motor vehicles contain the following notice on their label: This container should be visually inspected after a motor vehicle accident or fire and at least every 36 months or 36,000 miles, whichever comes first, for damage and deterioration.

In January of this year, the Clean Vehicle Education Foundation (CVEF) in Washington, D.C., launched a public awareness campaign to remind natural gas vehicle (NOV) owners of the need for CNG cylinder inspections. The campaign, which is part of a larger CNG cylinder safety program underwritten by the U.S. Dept. of Energy (DOE), is initially targeting fleet managers and automotive service technicians in the transit, refuse, school district, utility and government sectors, where use of NOVs is most prevalent. Other components of the program include scholarships for technicians to undergo inspection training and certification testing, collection of field observation data concerning in-service cylinder conditions and wear, and coordinating CNG inspection regimens with newly developed cylinder safety standards and practices for hydrogen powered vehicles.

Inspections performed by service stations or state agencies may or may not include a detailed CNG cylinder visual inspection, as outlined in a document developed by NOV industry engineers in conjunction with the Compressed Gas Association (CGA). If it is not part of the inspection already, it should be. Following practices specified in the CGA standard, a "qualified" inspector will note cuts, cracks, gouges, abrasions, discoloration, broken fibers, loose brackets, damaged gauges or isolators, heat damage or other problems, then recommend proper action to ensure fuel system safety. The inspection should also identify cylinders that have reached their "Do not use after" date, typically 15 years from the date of manufacture (although cylinders manufactured more recently may have longer approved useful lives).

According to CGA document C-6.4-1, a qualified CNG cylinder inspector must have ALL the following:

- knowledge of the types of containers used in CNG vehicle systems and damage allowances for each type;
- an understanding of inspection requirements, tests and procedures;
- the container manufacturer's current inspection guidelines readily available.

A qualified CNG cylinder inspector also must meet AT LEAST ONE of the following qualifications:

- a minimum of two years experience conducting container inspections; OR
- be supervised by someone with two years experience; OR
- be approved by the container manufacturer; OR
- be certified as an inspector by an organization with NOV training centers, an "authority having jurisdiction" or a nationally recognized certification testing organization. CSA is the only nationally recognized organization we know of that certifies CNG cylinder inspectors in the United States and Canada.

NOV fleet operators that do not have a qualified inspector on staff may want to contact their vehicle manufacturer, local gas utility or cylinder manufacturer, some of which offer cylinder inspection services by qualified inspectors. Another option is to visit the CSA International web page (<http://webtest.csa.org/cng/inspectors>) for a list of CSA-certified inspectors.

Training and CSA certification testing are available from a number of organizations nationwide. See the accompanying box for a list of those organizations. As noted earlier, scholarships for cylinder inspection training and certification testing are available through the DOE program administered by CVEF. These scholarships, which must be pre-approved by CVEF, provide reimbursement for successfully completing a cylinder inspector training program and passing the CSA test. For more information about cylinder inspection and training, and for information on the inspector training scholarship program, log on to www.cleanvehicle.org/technology/cylinder.shtml.

Hank Seiff is director of technology for the Clean Vehicle Education Foundation, where he coordinates a variety of technical programs and creates and standardizes development activities for natural gas vehicle and natural gas-to-hydrogen technologies. He can be reached by e-mail at hseiff@cleanvehicle.org or by phone at 703-334-6151.

For Cylinder Inspection Training & Certification:

- **Advanced Transportation Technology**
Internet: www.attotechnology.org/volunteers.html
Contact Cal Macy at cmacy@attotech.edu or 802-938-3067
- **ATV International**
Internet: www.atvinternational.net
Contact Bill McClatchey at wmcclatchey@worldnet.att.net or 304-290-6888
- **Energy Transfer Technology**
Internet: www.energytransfertechnology.com/auto_truck_4_sse.htm
Contact Scott Hammer at shammer@energytransfer.com or 314-855-8204
- **National Alternative Fuels Training Consortium**
Internet: www.naftc.org
Contact Al Elman at aelman@naftc.org or 304-893-7982
- **Natural Gas Vehicle Institute**
Internet: www.ngvpi.com
Contact Leo Thompson at leo@ngvpi.com or 800-810-8484

22 NATURAL GAS FUELS 4/2006

NFPA 52 inspection warning at CNG stations

8.14.12 A warning sign with the words “~~STOP MOTOR, NO SMOKING, FLAMMABLE GAS~~”

“A. STOP MOTOR

B. NO SMOKING

C. FLAMMABLE GAS

D. NATURAL GAS VEHICLE FUEL CYLINDERS SHOULD BE PERIODICALLY INSPECTED (NORMALLY EVERY 3 YEARS) TO ENSURE SAFE OPERATION OF THE VEHICLE. CONTACT VEHICLE OR CYLINDER MANUFACTURER shall be posted at the dispensing points.

A8.14.12 The following flyer is recommended to be made available by CNG dispensing facilities. The page is designed to be photocopied and cut into three sections for ease of distribution.

How to Tell if Your Compressed Natural Gas (CNG) Fuel Cylinders Have Been Inspected

The Department of Transportation requires this statement on the label of all CNG cylinders used on motor vehicles:

THIS CONTAINER SHOULD BE VISUALLY INSPECTED AFTER A MOTOR VEHICLE ACCIDENT OR FIRE AND AT LEAST EVERY 36 MONTHS OR 36,000 MILES, WHICHEVER COMES FIRST, FOR DAMAGE AND DETERIORATION

Image Courtesy of Lincoln Composites, Inc.

Evidence that your cylinders have been inspected could be:

1. a readily-visible inspection label on the cylinder:



Image
Courtesy
of
AFV
International

2. inspection form/report provided by inspector (perhaps kept in glove box with insurance, registration, etc. papers).
3. other – sticker on windshield, doorpost, fueling receptacle area, etc

For more information on CNG cylinder inspection, go to:

<http://www.cleanvehicle.org/technology/cylinder.shtml>

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PMVI procedure for AAMVA, CVSA

Suggested Wording for State PMVI (Periodic Motor Vehicle Inspection) and CVSA
(Commercial Vehicle Safety Alliance) Commercial Vehicle Inspections
(Last Revised 6-6-08)

Compressed Natural Gas (CNG) Fuel Systems

If the vehicle has a CNG fuel system which has not been disconnected and depressurized:

Examine the fuel system and reject vehicle for:

Any fuel leakage from the CNG fuel system detected by smell (CNG is odorized), sound or visible evidence (such as ice buildup at fuel system connections and fittings), and verified by a commercial leak detection fluid.

Examine the CNG fuel system and reject vehicle if:

1. The tank(s), tank mounting system and fuel system are not in serviceable condition and/or not securely attached or critical components are missing, disconnected, broken or loose.
2. There is obvious collision, chemical attack or fire damage to the fuel system. However the vehicle need not be rejected if it can be determined it has passed a detailed visual inspection (see below) since the time of the damage.
3. The vehicle system service (working) pressure on the label at the fueling connection receptacle is higher than the cylinder service (working) pressure on the cylinder label.
4. There is inadequate clearance to assure protection from mechanical damage or from the exhaust system.

Examine the CNG fuel cylinder(s) labels and reject vehicle if:

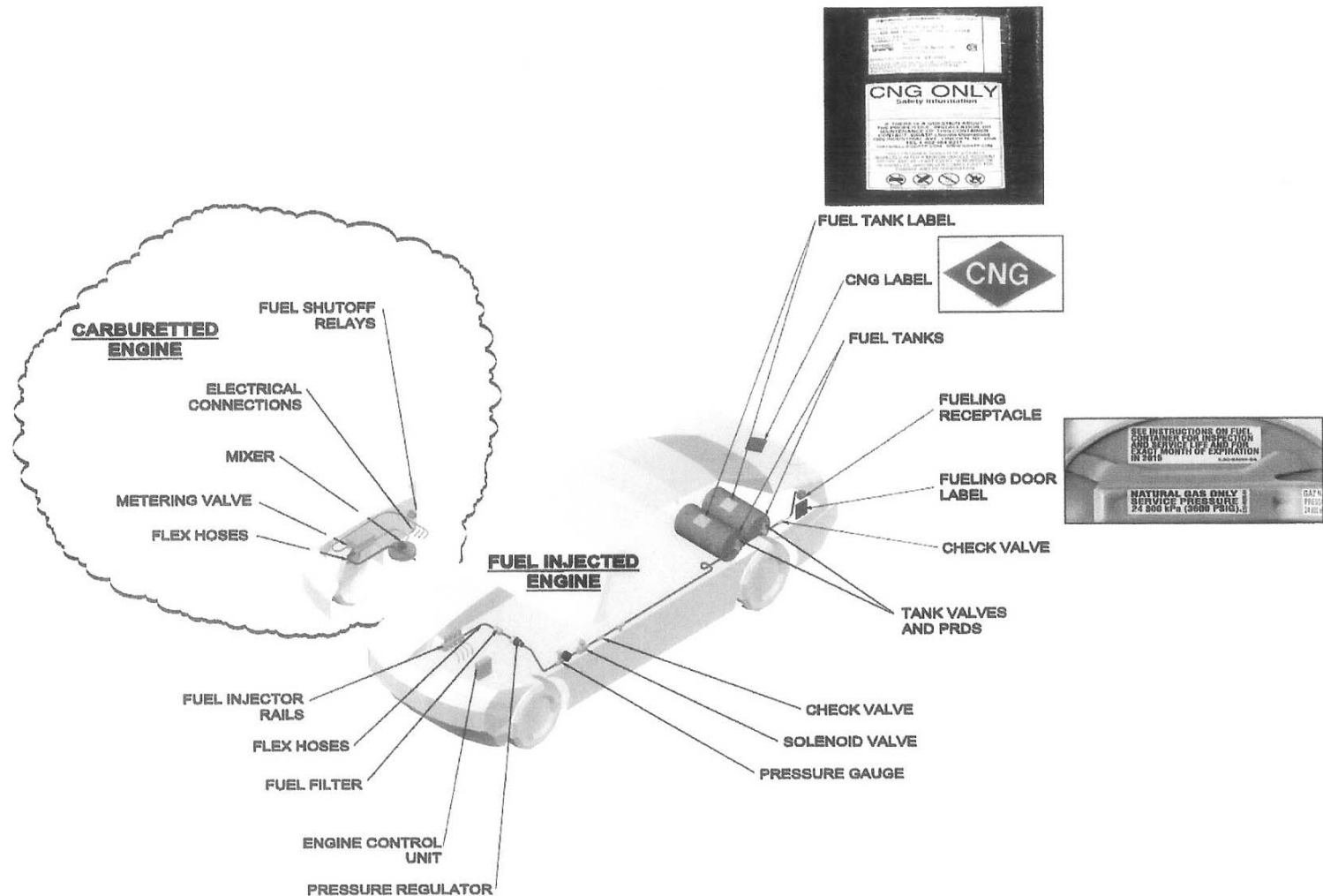
1. Information on cylinder manufacturer, service pressure, and "do not use after" date is missing or illegible
2. "Do not use after" date has passed

Reject vehicle if fuel cylinder(s) have not had a detailed visual inspection within the last three years or 36,000 miles, whichever is less.* Inspection may be documented by inspection labels or tags on the cylinders, inspection labels on the windshield, doorpost, etc., and/or by other documentation which the vehicle owner/operator may provide.

Reject vehicle if there is obvious serious damage or deterioration to the CNG fuel system.

* refer to §2.1.3 ANSI NGV 2, FMVSS 304 or other applicable federal, state or local standard.

Safety Note: CNG is extremely flammable. Avoid exposure to any ignition source if leakage is suspected. CNG rises so beware that leaking CNG may collect in pockets on the ceiling of structures and form flammable mixtures. Do not bring leaking (or suspected leaking) vehicles indoors; park leaking CNG vehicles outside in an uncovered location.

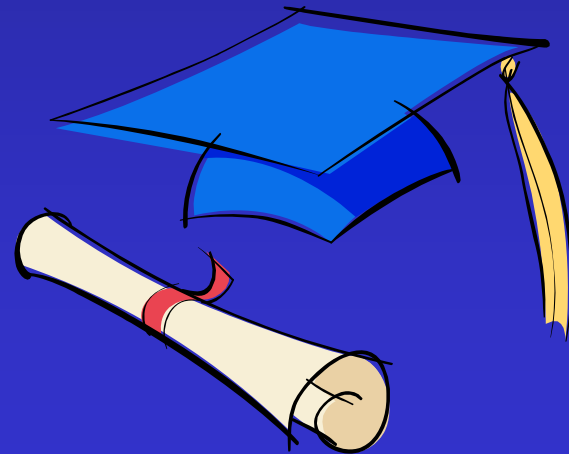


Sample Compressed Natural Gas Vehicle Schematic

Phase II – Training Scholarships or Tuition Assistance

Highlights:

- **284 cylinder inspection certification scholarships granted, 159 claimed to date**
- **TUG meeting held at LA Metro Oct 2006 trained 23**



Phase III – Evaluate Current Training and Testing Practices

Highlights:

- TUG, UPFC, fleets & others surveyed on adequacy and effectiveness of present cylinder training and certification program
- Three program partners trained and certified
- CSA cylinder inspector reports reviewed



- Information on foreign cylinder inspection & recertification practices obtained
- Worked with CSA to upgrade test
- Providing Training Guide



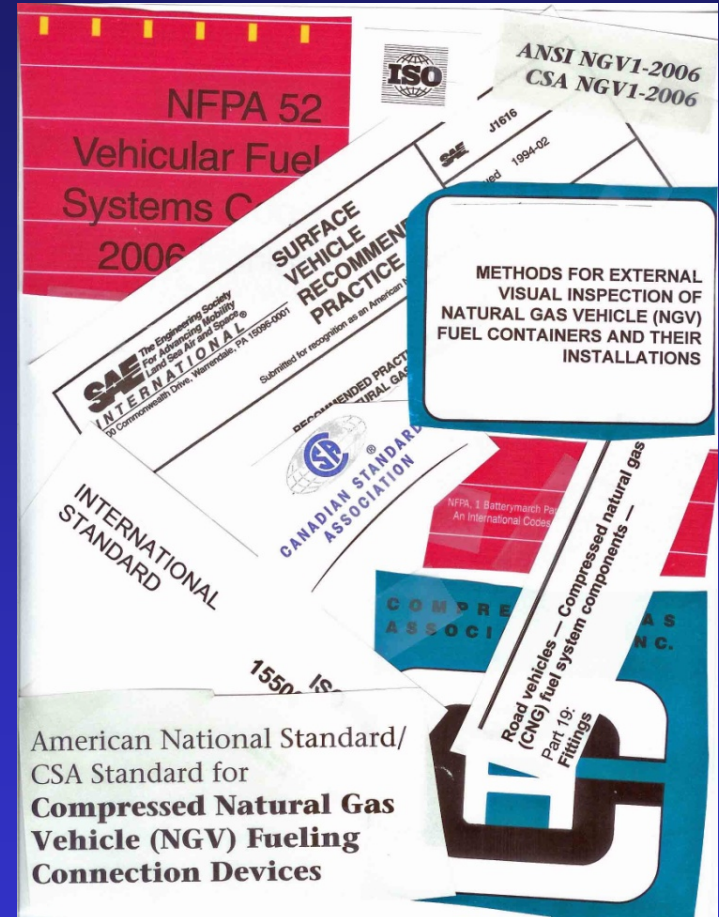
Phase IV – Safety Monitoring & Investigation

Highlights:

- Low-key industry incident reporting program reaffirmed
- Information on all 82 incidents on file from 1984-2008 digitized and available on CD
- Worked with SuperShuttle, and Philadelphia Gas Works Cylinder Rupture Investigations
- Provide Information to NGV Industry based on incident reports



Participate in Natural Gas Vehicle Codes and Standards Activities



Organizations with NGV C&S

- | | | |
|---------|-------|---------|
| - NFPA | - TX | - FMCSA |
| - NHTSA | - CA | - ASME |
| - CGA | - CSA | - NIST |
| - SAE | - UFC | - UL |
| - ISO | - ICC | - Other |

CSA

NGV 2-2007 (CNG Containers) - Corrections published

HGV 2 (H₂ Containers) - On hold pending SAE work

NGV 3.1 (Fuel System Components) - Being redrafted in ISO 15500 format (R&C Completed)

HGV 4.x (Hydrogen Fueling Station Tentative Interim Requirements) - soon to be published

PRD 1 (Pressure Relief Devices) - being updated

HPRD 1 (H₂ PRDs) - R&C comments being reviewed

NFPA

NFPA 52 (Fuel Systems Code) - Final ballot on changes for 2009 version has been completed. NITMAMs submitted for Spring 2009 meeting.

NFPA 2 (Hydrogen Technologies Code) - publication planned for 2010

NFPA 30A (Motor Fuel Dispensing Facilities and Repair Garages) – latest edition published in 2008

UL

UL 558 (Industrial Trucks) – CVEF is working with UL to add language to add CNG to this standard

SAE

J2343 (LNG M and HD Vehicles) – rewrite published July 08

J1616 – (CNG Composition) – rewrite process beginning

J2700 – (LNG Tanks) – draft delayed – need industry support

J2699 – (LNG Composition) – in final stages of approval to be published this year

J2645 – (LNG Metering and Dispensing Systems) – revised to include definitions for LNG equivalents for DGE and GGE

J174 – LNG Connector – Limited interest – need industry support

ISO

14469-3 (CNG Connectors) – 250 Bar connector approved and published

14469-2 – Size 2 connector in FDIS stage

15500-20 – Non stainless rigid fuel line approved and published

15500 -3,4,6,9,14,16,17,18,19 – Road Vehicle CNG – under review

12614 – Road Vehicles –LNG Fuel Systems – new project

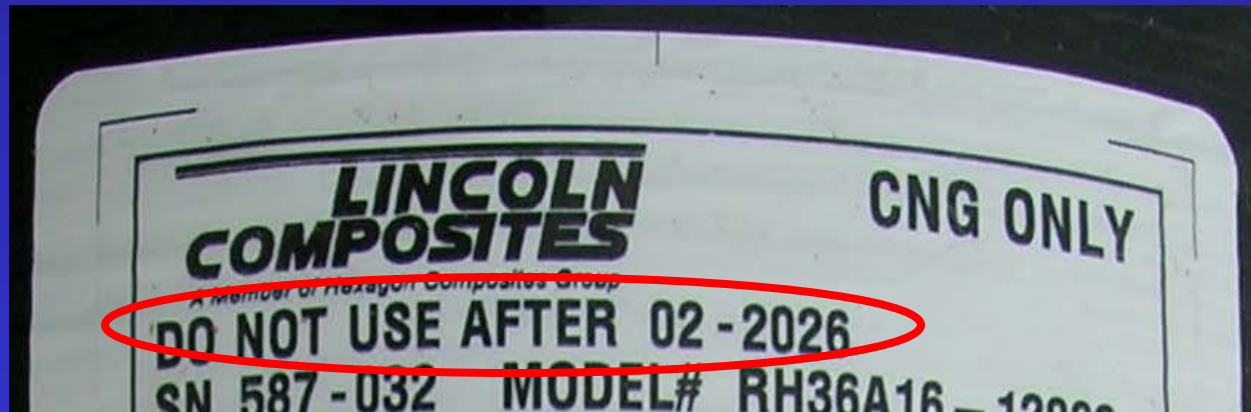
12617 – LNG Fueling Connector – New Project

12619 –Compressed Hydrogen & Hydrogen Blends – New

Phase V – CNG Cylinder Recertification

Highlights:

- Fleet surveys indicated desire for recertification
- NGV 2 will include procedure for recertifying steel type 1 cylinders, based on Canadian practice



Phase VI – CH₂ and HCNG Cylinder Safety

Highlights:

Participating in H₂ C&S activities of CSA, SAE, NFPA and ISO



DRAFT INTERNATIONAL STANDARD ISO/DIS 15869.2

ISO/TC 197

Secretariat: **SCC**

Voting begins on:
2006-06-01

Voting terminates on:
2006-08-01

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks

Hydrogène gazeux et mélanges d'hydrogène gazeux — Réservoirs de carburant pour véhicules terrestres

ICS 43.060.40

Published technical paper for hydrogen vehicle industry – “Some Things to be Learned from the ‘Other’ Compressed Gas Fuel”

Some Things to be Learned from the “Other” Compressed Gas Fuel System

Henry E. Seiff
Clean Vehicle Education Foundation

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ABSTRACT

Compressed natural gas vehicles were first commercialized after World War II in Italy. There are now seven million CNG vehicles on the road worldwide. The first US CNG vehicle “incident” in our files dates to 1984. “Those who cannot learn from history are doomed to repeat it” (1), so this paper will explore a few of the things to be learned from CNG vehicle history that can help assure the safety of compressed hydrogen tanks and fuel systems.

A LITTLE BACKGROUND INFORMATION

Compressed natural gas as a motor vehicle fuel has been around for a long time.



Figure 1: Historic CNG vehicle and equipment (2)



Figure 2: 1932 Chrysler “Ironside” powered by a Mogas Natural Gas System (3)

Although low in number in the United States, worldwide there are seven million natural gas vehicles (NGVs) on the road today and a target of 50 million for 2020 (4). Natural gas vehicles offer some major advantages, such as:

- they use zero petroleum
- they are inherently cleaner burning than gasoline or diesel
- they produce around 25% less Greenhouse gas
- the fuel is less expensive on an energy equivalent basis

and some disadvantages:

- the fuel system costs more to produce
- the fuel system takes up more space and weighs more for the same driving range
- there is a limited natural gas fueling infrastructure in place

Present program completed at end of 2008

however we hope to obtain DOE or CA money to
continue it

